



Engineering Investigations Reports

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M e m o r a n d u m

Date : September 30, 1998

To : Naser Bateni, Chief
Northern DistrictFrom : Douglas Denton, Chief
Water Supply Evaluations Section
Department of Water Resources

Subject: Transmittal of Offstream Storage Engineering Progress Report

Introduction

The work plan and schedule for the Offstream Storage Investigation was completed around November 1997 and the Water Supply Evaluations Section was assigned the following engineering tasks:

- a. Review past studies, maps, and backup reports.
- b. Compile existing or new maps, aerial photographs, and other basic data.
- c. Develop and design cost estimates of alternative projects.
- d. Collect and analyze existing hydrology required to identify potential water supplies.
- e. Evaluate project flood control potential.
- f. Evaluate alternative project formulations.
- g. Perform initial operation studies to rank project formulations by water yield potential.
- h. Contract with other DWR Branches to complete the following activities:
 1. Routing and cost estimates of alternative water supply conduits from the Sacramento River to Sites/Colusa Reservoir.
 2. Statewide operation studies.

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Doug Denton
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3. Design and cost estimates of required pumping and generating (electrical) systems.
4. Review by Division of Engineering of all District design and cost estimates.

Description of Water Project Alternatives Under Investigation

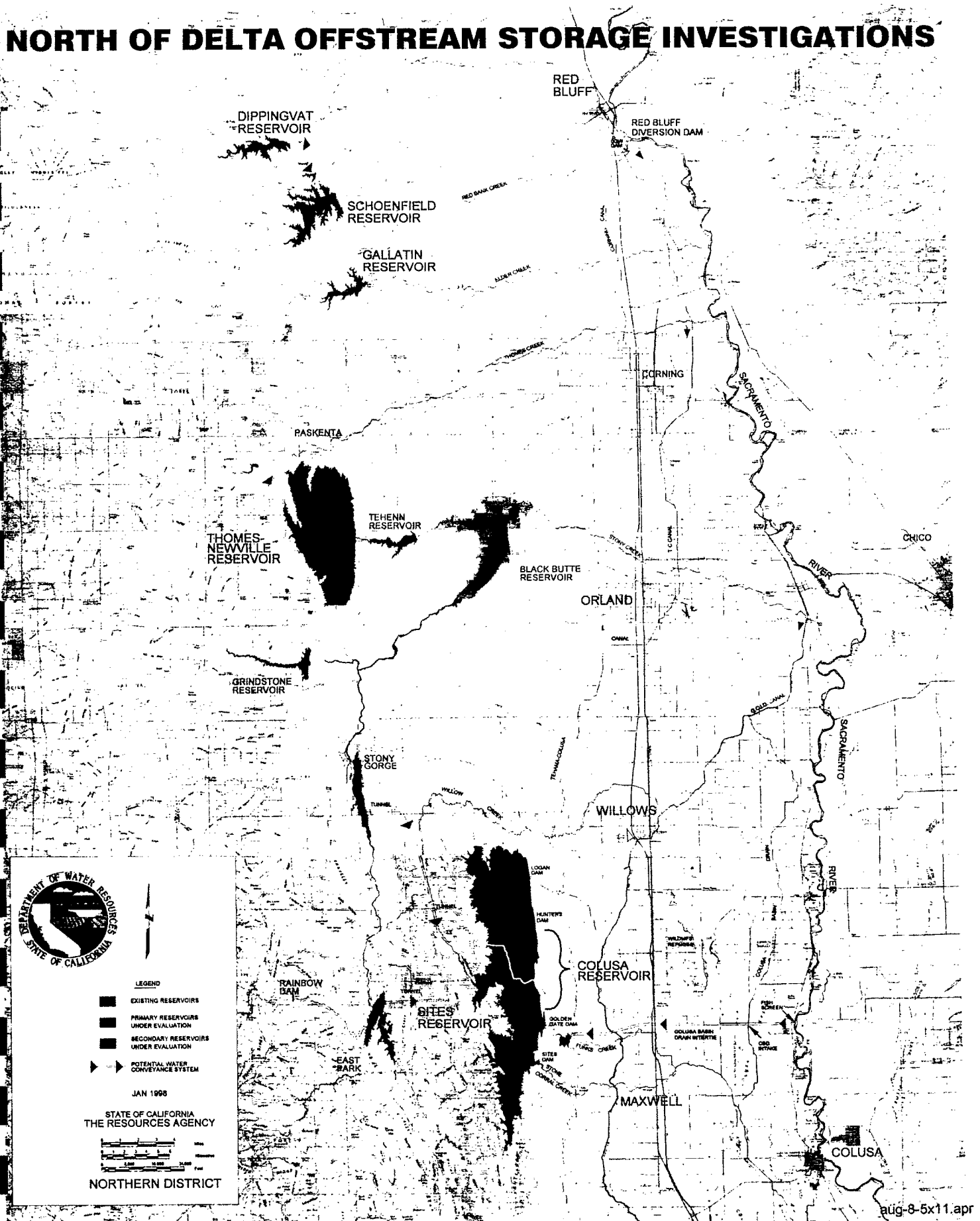
The Offstream Storage Investigations focus on four offstream storage projects upstream of the Delta on the west side of the Sacramento Valley roughly between Maxwell and Red Bluff. The four projects are Sites, Colusa, Thomes-Newville, and Red Bank shown on Figure 1. All of these projects have been investigated in the past to some degree. Investigation of the four alternative projects is being done in full cooperation and coordination with the ongoing CALFED Bay-Delta Program.

All of these projects are classified as offstream storage because almost all of the water required to fill them would be transported from the Sacramento River, the Colusa Basin Drain or tributary streams such as Stony, Thomes, or Red Bank creeks. Natural inflow to the Reservoirs would generally be less than the evaporation loss from them. The basic operating regime of these reservoirs would be to divert high (above existing water rights) winter and early spring flows into them from one or more of the above listed sources through the existing or enlarged Tehama-Colusa or Glenn-Colusa Irrigation District canals or other new canal alignments. From May through October, reservoir releases could be made back to these canals for local irrigation and wetlands use in exchange for water which would otherwise have been diverted from the Sacramento River during this period. This undiverted water would become available for other downstream uses. The complex engineering, environmental, and economic issues of how to divert and convey water from the Sacramento River to the Sites/Colusa or Thomes-Newville projects are discussed in a separate memorandum. This section contains information on the potential water supplies from nearby tributary streams.

Sites/Colusa Projects Description

The Sites/Colusa projects would be about 10 miles west of Maxwell in and north of Antelope Valley across the Stone Corral, Funks, Hunters, and Logan Creek Drainages. What historically has been called the Sites/Colusa Project is really three different projects occupying the same general project location: (1) Small Sites sized at around 1.2 million acre-feet, (2) Large Sites sized at a

NORTH OF DELTA OFFSTREAM STORAGE INVESTIGATIONS



Naser Bateni, Chief
September 30, 1998
Page Four

maximum of around 1.8 million acre-feet, and (3) Colusa, (or the Largest Sites), sized at approximately 3 million acre-feet. The greatest difference in projects is between Large Sites and Colusa which is formed by not blocking the natural ridge between Funks and Hunters Creeks with saddle dams (to form 1.8 million acre-feet Sites) and instead allowing these drainages plus Stone Corral and Logan creeks to form one large reservoir. Of course this would require the construction of three additional (to Large Sites) major dams and nine sizable saddle dams along the northern edge of the Logan Creek Drainage which would be the northern boundary of Colusa Reservoir. Most of Large Sites reservoir lies within Colusa County; the much larger Colusa Project would lie about half in Glenn County. The Sites/Colusa Projects were investigated at a reconnaissance level in 1964 by the Bureau of Reclamation and again in the early 1980's by the Bureau and DWR.

Thomes-Newville Project Description

The Thomes-Newville Project was last investigated by DWR in the late 1970's and early 1980's as documented in a November 1980 Engineering Feasibility Report. This report concluded that the Thomes-Newville Reservoir Plan was feasible from an engineering viewpoint but that many environmental issues remained to be worked out. After the statewide negative vote on the Peripheral Canal in 1982, further consideration of this project was dropped until recently. This project is now being re-evaluated as an alternative to a potential Sites/Colusa project. The reservoir size range of Thomes-Newville at around one to three million acre-feet is similar to that of the Sites/Colusa complex and at present it appears to be a relatively equivalent and a viable alternative.

The Thomes-Newville Project is on the North Fork of Stony Creek, about 20 miles west of Orland and six miles upstream of existing Black Butte Reservoir. The reservoir would be formed by one major dam 280 to 380 feet high at Newville and a relatively small saddle dam at Burrows Gap three miles south. The elliptical shaped reservoir would occupy from 12,000 to 17,000 acres of mainly grasslands historically used for grazing.

This is also an offstream storage project because it has very little natural inflow and must be supplied from nearby streams (Stony and Thomes Creeks) and possibly the Sacramento River. These diversions from other streams would require construction of some elaborate and costly diversion and conveyance systems. For example, to divert winter water from main Stony Creek at Black

Butte Reservoir into Thomes-Newville, a small conveyance reservoir (Tehenn) and two large pumping plants would be required.

Red Bank Project

The Red Bank Project would be created by the construction of two moderate size reservoirs and two small conveyance reservoirs in the upper South Fork Cottonwood Creek and Red Bank Creek Watersheds, approximately 20 miles west of Red Bluff. Total storage of these reservoirs would be around 350,000 acre-feet and the two main dams would be between 250 and 300 feet high.

This project is dissimilar from the preceding projects in the following significant aspects:

- (1) At 0.35 MAF storage, it is much smaller than any of the other alternative projects and would result in a much smaller yield of new water.
- (2) It would require a major dam on the South Fork Cottonwood Creek which will block access of anadromous fish to the creek above the dam.
- (3) Its water supply would be limited to the relatively small natural inflows of watersheds above the dams and no inflow from the Sacramento River or tributaries would be storable.
- (4) It has the capability of supplying the entire length of the Tehama-Colusa Canal with a short-term water supply during periods when the Red Bluff diversion dam is inoperable due to adverse fishery impacts.
- (5) This project has the capability of providing a portion of winter inflows for long term storage to the Sites/Colusa or Thomes-Newville projects by conveyance through the Tehama-Colusa Canal. This could be accomplished through the construction of only one of the dams.

Because of the above characteristics the Red Bank Project should be considered as a special case alternative for possible combination with another larger project, but not by itself a viable alternative to any of the other projects.

Other Projects Under Consideration

Early in this investigation we endeavored to identify other potential projects or varied project configurations which appeared worth investigating further. The following projects and concepts were generated and investigated to varying degrees as discussed below:

- (1) Enlargement of Existing Black Butte Reservoir. This reservoir can be enlarged from its present capacity of around 143,000 acre-feet to around 500,000 acre-feet by raising it approximately 60 feet. This would substantially increase the yield and flood control capacity of Black Butte Reservoir but, would require around 8 million yards of fill to construct a new dam and several miles of dike. It would displace the existing project that still has considerable useful life. The incremental increase in storage is around 360,000 acre-feet. Because of the topography at this site, long reaches of levee must be constructed to prevent water from spilling into adjacent drainages requiring a very large amount of fill and high costs. Therefore, after initial consideration we decided to defer this option from further investigation because it did not appear to offer any special benefits in comparison to other alternatives and presented some difficult problems to solve.
- (2) Diversion of Stony Creek Flows. Diversion of Stony Creek flows from Stony Gorge and East Park reservoirs to Sites/Colusa is an attractive alternative because gravity-flow water free of anadromous fishery problems is available. An average of around 70,000 acre-feet of water per year can be diverted from Stony Gorge Reservoir and about half that amount from East Park Reservoir. The capital cost of the conveyance system from Stony Gorge is estimated at around \$400 million and from East Park at around \$100 million. Based on these preliminary (unreviewed) cost estimates it appears that diversions from East Park offers the lowest unit costs of the two alternatives and may be a desirable source of water.
- (3) Construction of a Reservoir on Grindstone Creek. A dam and reservoir on Grindstone Creek about 4 miles above its confluence with Stony Creek was

initially investigated as a potential gravity-flow source of water to either Sites/Colusa or Thomes-Newville. A long and costly conveyance system would be required to transport this water to either offstream storage reservoir, but from 60 to 80 thousand acre-feet of additional water could be supplied. This potential water supply was evaluated at a cursory level but was deferred because of the following factors; The dam requires a comparatively large quantity of fill in relation to the amount of water stored; it is in an area of potentially high seismic activity and; the reservoir is subject to large landslides which could result in destructive reservoir wave action. The long and costly conveyance system also detracts from this alternative. Most of the quantity of water that this alternative would have diverted could be developed in less costly ways such as: (a) by re-operating Stony Gorge Reservoir to maximize diversion to Sites/Colusa and making up the relatively small losses to downstream water users through guaranteed deliveries from other sources, or (b) by pumping water from Black Butte Reservoir into the Thomes-Newville Reservoir.

- (4) Construction of a reservoir on Elder Creek. A dam on Elder Creek between Red Bank and Thomes creeks was investigated on a cursory basis at the beginning of this investigation. Such a project was studied during the 1970's as part of the Westside Conveyance System proposed to transport water from the upper Sacramento River to the Delta. A favorable damsite exists on Elder Creek but its water supply at around 60,000 acre-feet per year is relatively small and its divertable quantity is substantially less due to existing water rights. In addition to the main dam required to store creek flows a lower dam with fish screen and ladder would be required to divert this water into the T-C canal for conveyance to the Sites/Colusa or Thomes-Newville project. Because of these issues, after initial consideration this alternative was deferred from further evaluation at this time.
- (5) Construction of the Dippingvat Project Alone. Dippingvat and Schoenfield Reservoirs plus a conveyance system between them compose the Red Bank Project which is one of the four main alternatives presently under investigation. A variation of this project which we are considering is construction of only Dippingvat Reservoir on the South Fork of Cottonwood Creek with a tunnel diversion to Red Bank Creek. The purpose would be to store and divert flows from Cottonwood Creek to Red Bank Creek for ultimate diversion into the T-C canal and conveyance to Sites/Colusa or Thomes-Newville Reservoir. Approximately 76,000 acre-feet per year of

flow to an offstream storage reservoir could be developed by this alternative. A low diversion structure to the T-C canal near the mouth of Red Bank Creek with a fish screen and ladder would be required. This alternative is still under consideration and the greatest potential detriment is impacts to the Cottonwood Creek anadromous fishery caused by blockage of access to 100 square miles of watershed above Dippingvat Dam.

- (6) Diversion of Flows from Tributary Streams. Diversion of flows above existing water rights during winter and early spring from nearby tributary streams is being investigated. These streams include Stony, Thomes, Red Bank, and South Fork Cottonwood creeks as well as the Colusa Basin Drain. Although the Sacramento River is still viewed as the most likely source of water for offstream storage projects, diversion from tributary streams warrants evaluation as an alternative source that may be less environmentally sensitive. The amount of water available from these tributaries is substantial and is discussed in detail in a hydrology memo available on request. A summary of tributary water supply potential is given later under the heading "Hydrology and Water Supplies."

Engineering Work Completed to Date

The engineering work effort is approximately half completed. The following is a status report at the mid-point of the program. The work items that have been largely completed are: collection and initial review of past studies, maps, and backup reports; creation of updated maps and aerial photographs; initial contact with property owners, preparation of property ownership maps, initiation of temporary entry permit process, and collection of existing hydrology data. The major items which we continue to be heavily involved in are: dam and reservoir designs and cost estimates, operation studies reservoir water supply sources, and project formulation. These work items are discussed in greater detail below.

Designs and Cost Estimates

The majority of the work in this category to date has been performed on the Sites/Colusa project because it is the alternative with the lowest level of past investigative effort. Both the Thomes-Newville and Red Bank projects have previously been investigated to the near-feasibility level but the historic work level at Sites/Colusa has not exceeded reconnaissance level.

Naser Bateni, Chief
September 30, 1998
Page Nine

At Sites/Colusa we have completed new mapping at the main and saddle dam sites by converting metric based mapping done earlier by the Bureau of Reclamation to English units. We recalculated dam earthwork volumes based on this mapping and we are in the process of designing dam appurtenances such as the spillway, emergency outlet, and pump/generator penstocks. We are nearing completion of design at this project location and will start the cost estimation phase soon. Less effort will be required to complete the design and cost estimate work at the other projects because of the higher level of existing information. This work at all dam and reservoir sites should be completed by February 1999.

Other ongoing design and cost estimating work is concentrated on diversions from Upper Stony Creek to the Sites/Colusa Project, and from Thomes Creek into the T-C Canal for conveyance to the Sites/Colusa Project. Working draft memorandums on these projects are available on request.

Hydrology and Water Supplies

About one third of our Section's investigative effort to date has been spent on this critical area. Large reservoir sites are available along the westside of the Sacramento Valley; but locating, diverting, and transporting adequate water to fill them is a major engineering challenge. Therefore, identifying adequate water supplies for these reservoirs is critical to determining their feasibility.

The Sacramento River has historically been considered as the primary potential source of water to westside offstream storage projects; although, the 1980 Thomes-Newville Engineering Feasibility Report presented a preferred alternative which relied totally on Stony and Thomes creeks for its water supply. The Sacramento River is still the major potential source of water supply to these projects, but we also are evaluating the potential of Stony, Thomes, Red Bank, and South Fork Cottonwood creeks, as well as, the Colusa Basin Drain to augment or replace the river supply. There may be environmental and flood control advantages to diverting from tributary streams. Future studies will determine this. Because the hydrology of the Sacramento River is readily available and routinely used in statewide project operation studies we concentrated our work mainly on the above mentioned tributary streams.

The primary objectives of our hydrology and water supply studies were to determine the location and amount of all potentially available water supply sources, determine how much water could be diverted with various size diversion capacities, and determine which combination of diversions may be most

Naser Bateni, Chief
September 30, 1998
Page Ten

cost-effective. We have mainly completed the first two objectives but are still working on the third. A brief summarization of our results is shown on Figure 2 and in a 25 page memorandum detailing the hydrology and water supply studies.

Thru these studies we tentatively determined that a sizable amount of water is available for diversion from tributary streams in comparison to that which could be diverted from the Sacramento River.

Project Formulation and Operation Studies

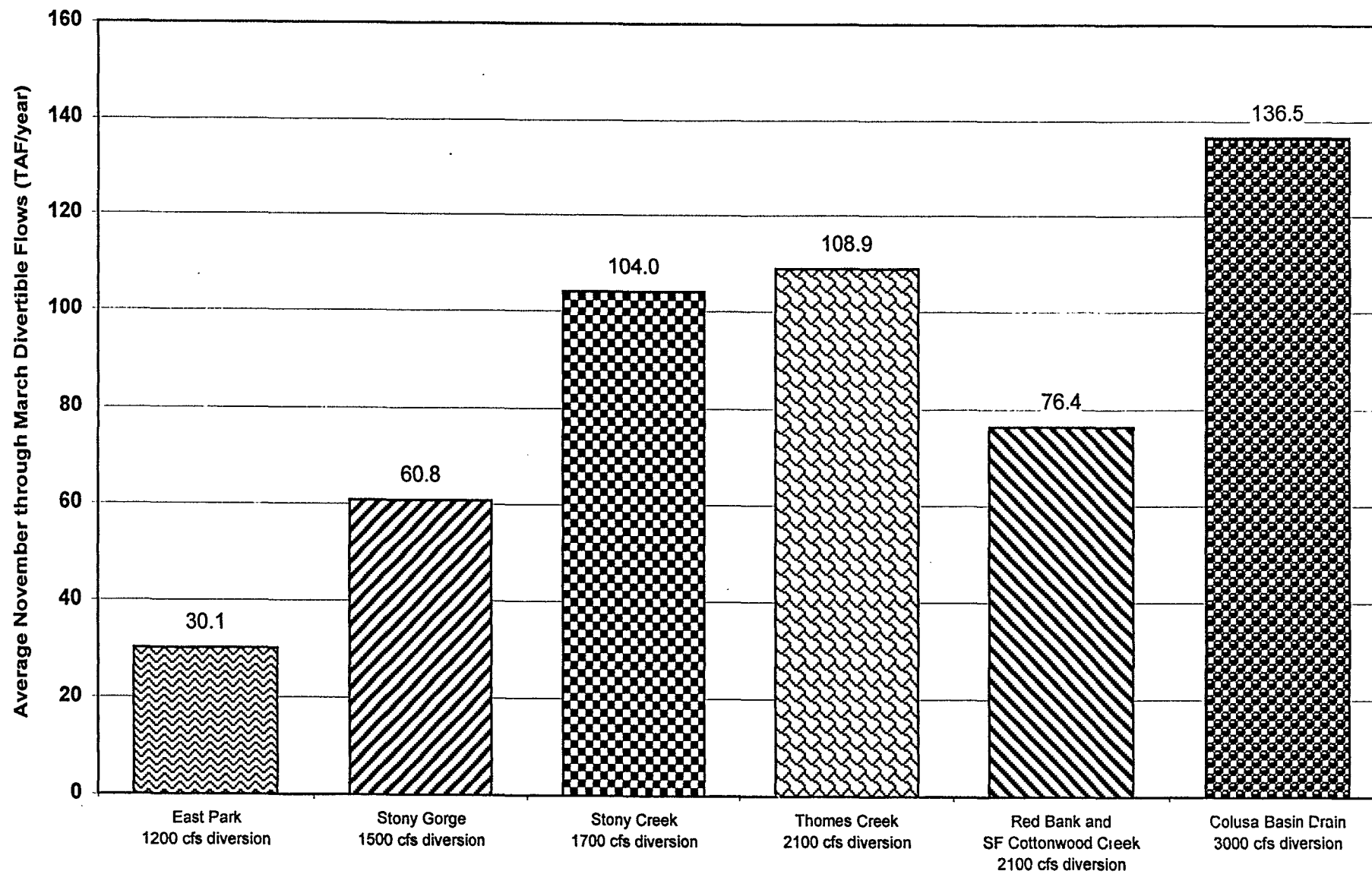
The next step in building on the hydrology analysis is to begin configuring various alternative projects and running operation studies to determine how much new water they produce. We recently started this process by supplying the DWR Hydrology Modeling Branch with data and requesting they begin initial statewide operation studies. Results from this work should be available around November. More runs for refinement will be requested after results from the initial runs are available.

Interim Findings

It is too early in this investigation to draw conclusions regarding the engineering feasibility of these potential offstream storage projects. Key cost estimating and operation studies are not yet completed. However, we have developed a few interim findings that will probably still be valid at the end of this study:

- (1) No insurmountable engineering problems have been identified. All of the projects under investigation appear possible to build using standard construction practices. The greatest issue facing these projects will likely be their total cost in comparison with their water supply yield and the willingness of beneficiaries to pay for this water.
- (2) Several potential projects that appeared promising at the beginning of this study have become less desirable after initial investigation and have been deferred from further consideration. These projects include Grindstone Reservoir and Diversion, Black Butte Reservoir Enlargement, and Gallatin Reservoir on Elder Creek.
- (3) A large quantity of water ($\geq 400,000$ acre-feet/yr.) can be obtained from tributary streams including Stony, Thomes and Red Bank

Figure 2
Potential Water Supply Sources for Offstream Storage Projects
Average November through March Divertible Flows
1945 - 1994



creeks plus the Colusa Basin Drain to supply offstream storage reservoirs. It may be preferable for environmental and economic reasons to obtain part or all of the offstream storage water supply from these tributaries.

- (4) At present the Large Sites Project appears to be the most efficient size of the three Sites/Colusa alternatives under consideration. At 1.8 maf this project maximizes the capacity of the Sites potential storage area and would have a comparatively high water storage to dam volume ratio. Expanding the reservoir into Hunters and Logan Creek basins to form Colusa Reservoir would lower this ratio and substantially increase unit storage cost.
- (5) The previously investigated Red Bank Project was planned to be created by two major dams, one each on the S. F. Cottonwood Creek and Red Bank Creek. During current investigation we are also considering the option of constructing only the Dippingvat Dam on Cottonwood Creek for diversion of winter flows to Red Bank Creek. This diverted water would then be routed to the entrance of the T-C Canal via a small diversion near the mouth of Red Bank Creek from where it would be conveyed for storage in an offstream storage reservoir.

Remaining Work Items for Completion of Investigation

The following major work items remain to be completed during coming months:

- (1) Design and Cost Estimates - This work is nearing completion for the Sites/Colusa alternatives but has not started yet on the Thomes-Newville and Red Bank Projects. However, the past studies on these projects is at a much higher level; therefore, the amount of additional work which must be done to complete them is less.
- (2) Project Formulation and Operation Studies - The first twelve operation study runs are presently being made and it will probably be necessary to run at least twice that number to adequately make project comparisons for selection of near optimum project configurations.

Naser Bateni, Chief
September 30, 1998
Page Thirteen

- (3) Completion of Pumping /Generating Plant Design and Energy Use Analysis - This work will be completed by the Division of Engineering.
- (4) Project Economic Evaluation - This work will be completed by the Economics Analysis Section in Sacramento.
- (5) Review of all Design and Cost Estimation Work - This work will be completed by Division of Engineering.
- (6) Preparation of End-of-Study Report - The report writing phase will require approximately six months of part-time effort to author and edit two drafts and the final report. Investigation and planning work will continue during this phase.